

**Supplemental Specification
2005 Standard Specification Book**

SECTION 03310

STRUCTURAL CONCRETE

Delete Section 03310 and replace with the following:

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Materials and procedures for constructing structural concrete, including box culverts, concrete slope protection, diversion boxes, catch basins, cleanout boxes and other items as specified.
- B. High Early Strength Concrete for closure joint at each end of bridge deck and the longitudinal or transverse closure joints between all the precast concrete deck panels, bridge parapets and approach slabs as shown on plans.

1.2 RELATED SECTIONS

- A. Section 00555: Prosecution and Progress
- B. Section 02317: Structural Excavation
- C. Section 02752: Portland Cement Concrete Pavement
- D. Section 03055: Portland Cement Concrete
- E. Section 03152: Concrete Joint Control
- F. Section 03211: Reinforcing Steel and Welded Wire
- G. Section 03390: Concrete Curing
- H. Section 05822: Bearings
- I. Section 05832: Expansion Joints

1.3 REFERENCES

- A. AASHTO M 85: Standard Specification for Portland Cement (Chemical and Physical)
- B. AASHTO M 111: Zinc (Hot-dip Galvanized) Coatings on Iron and Steel Products
- C. AASHTO M 148: Liquid Membrane-Forming Compounds for Curing Concrete
- D. AASHTO M 153: Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
- E. AASHTO M 213: Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- F. AASHTO M 235: Epoxy Resin Adhesives
- G. AASHTO LRFD Bridge Construction Specifications Section 3 (Temporary Works)
- H. ASTM C 578: Rigid, Cellular Polystyrene Thermal Insulation
- I. American Concrete Institute (ACI) Standards

1.4 SUBMITTALS

- A. Falsework Drawing:
 - 1. When required in the contract or requested by the Engineer, submit for approval three copies of falsework drawings and design calculations (prepared and sealed by a licensed professional engineer in the State of Utah) at least two weeks before construction starts or electronically at least one week before construction starts.
 - 2. Comply with AASHTO LRFD Bridge Construction Specifications Section 3 (Temporary Works).
- B. When specified in the plans, design and submit to the Engineer for approval a High Early Strength Concrete mix design, which attains a 24 hour compressive strength of 3000 psi and a 28-day compressive strength (f'_{c}) of 4000 psi minimum. Provide a certificate stating that the mix submitted meets the requirements for coarse aggregate, fine aggregate, cement, water, admixtures and curing materials in Section 03055 at least two weeks before its use.
- C. Cold Weather Plan according to this Section, article 3.8.

- D. Surface Evaporation Plan according to this Section, article 3.8.

1.5 ACCEPTANCE- Price Adjustments for Strength

- A. Use a pay factor of 1.0 when concrete strength meets or exceeds the specified strength.
- B. When concrete is below specified strength:
1. Department may accept item at a reduced price.
 2. The pay factor applies to the portion of the item that is represented by the strength tests that fall below specified strength.
 3. Department calculates the pay factor as follows:

Percent below specified strength:	Pay Factor:
0-2 percent	0.9
2-4 percent	0.8
4-6 percent	0.7
6-8 percent	0.6
8-10 percent	0.5
 4. Remove and replace all concrete represented by the test if the concrete strength is less than 90 percent of the specified strength.

PART 2 PRODUCTS

2.1 CONCRETE

- A. Class AA(AE) concrete, unless specified otherwise.
1. Meet a 28-day flexural strength of 650 psi verified through trial batch.
- B. Concrete Slope Protection: Class A(AE).
- C. Refer to Section 03055.
- D. For High Early Strength Concrete use air-entrained concrete composed of Portland Cement, fine and coarse aggregate, admixtures, and water.
1. Use either air-entraining Portland cement or an approved air-entraining admixture to obtain the air-entraining feature.
 - a. The entrained air content to be no less than 4 percent or more than 7 percent.
 2. Conform to the requirements of AASHTO M 85 for cement.

2.2 REINFORCING STEEL AND WELDED WIRE

- A. Refer to Section 03211.

2.3 JOINTS AND SEALERS

- A. Pre-Molded Joint Filler meeting AASHTO M 153.
 - 1. Concrete Slope Protection: Refer to Section 03152.
- B. Preformed Joint Filler: AASHTO M 213.

2.4 BACKER ROD

- A. Use backer rod composed of closed-cell polyethylene foam of sufficient size to prevent the sealant from passing to the bottom of the groove.
- B. Refer to Section 03152.

2.5 WATERSTOPS

- A. Refer to Section 03152.

2.6 RIGID PLASTIC FOAM

- A. Preformed, extruded, cellular polystyrene thermal insulation material that has a water absorption property of 0.3 or less.
- B. Refer to ASTM C 578.

2.7 CURING COMPOUND

- A. As specified. AASHTO M 148, Type I-D, Class A.

2.8 FORMS

- A. Plywood, wood, metal, glass, or a combination of these materials.

2.9 MISCELLANEOUS STEEL ITEMS

- A. Galvanize all miscellaneous steel items permanently cast into structural concrete elements (AASHTO M 111).

PART 3 EXECUTION

3.1 PREPARATION

- A. Falsework
 - 1. Construction:
 - a. Use materials able to sustain the stresses required by the falsework design.
 - b. Use suitable jacks or wedges to set the forms to the grade or camber required, and to prevent settling.
 - c. Produce a finished structure of the specified camber, and built to the lines and grades indicated.
 - 2. Footing Construction:
 - a. Build falsework on a solid footing that is safe against undermining, protected from softening, and capable of supporting any imposed loads.
 - b. Demonstrate that the soil bearing values do not exceed the supporting capacity of the soil. (Conduct load tests or have soils investigation conducted by a licensed professional engineer.)
 - c. Use piling or caissons to support falsework that cannot be founded on a solid footing.
 - d. Space, drive, and remove piles following approved falsework drawings.
 - 3. Design and construct all falsework according to AASHTO LRFD Bridge Construction Specifications Section 3 (Temporary Works).
- B. Forms
 - 1. Use mortar-tight concrete forms, true to the dimensions, lines, and grades of the structure, and of sufficient strength to prevent deflection during the placement of concrete.
 - 2. Discontinue using any form or forming system that produces a concrete surface with excessive undulations until modifications have been made. Undulations are excessive if they exceed either $\frac{1}{8}$ inches or $\frac{1}{270}$ of the center-to-center distance between studs, joints, forms, fasteners, or wales.
 - 3. Countersink all bolt and rivet holes when using metal forms for exposed surfaces so that a plane, smooth surface of the desired contour is obtained.
 - 4. Use lumber that is free of knotholes, loose knots, cracks, splits, warps, or other defects that affect the strength or appearance of the structure. Rough lumber may be used for forming surfaces if visible rough surfaces do not show on the final structure.
 - 5. Form all exposed surfaces of each element of a concrete structure with the same forming material or with such materials that produce a concrete surface that is uniform in texture, color, and appearance.

6. Clean the inside surface of forms of all dirt, mortar, and foreign material before concrete placement.
 7. Use form oil that permits the ready release of the forms and does not discolor the concrete.
 8. Do not place concrete in the forms until:
 - a. All work connected with form construction has been completed.
 - b. All embedded materials have been placed.
 - c. All dirt, chips, sawdust, water, and other foreign materials have been removed.
 - d. Inspection and approval have been obtained.
 9. Do not use stay-in-place deck forms unless otherwise specified.
- C. Footings
1. Excavation: Refer to Section 02317.
 2. The Engineer may direct written changes in dimensions or elevations necessary to secure a satisfactory foundation.
 3. Do not dewater by pumping during concrete placement, or for 24 hours thereafter, unless pumping is outside the enclosure. Do not use well points to dewater footing.

3.2 GIRDERS, SLABS, AND COLUMNS

- A. Deck: Cure deck concrete at least seven days and until it has attained required design strength before placing parapet forms or leave all falsework in place and design it to carry all additional loads that are part of the parapet placement process.
- B. Slab Span: Place concrete in one continuous operation.
- C. Cast-In-Place T-Beams:
1. Place concrete in one or two continuous operations: The first to the top of the girder stems and the second to completion.
 2. Obtain a bond between the stem and slab that is positive and mechanical, and secured by means of shear keys in the top of the girder stem.
- D. Concrete in columns:
1. When column is being placed on a footing, allow footing concrete to set until it has attained 75 percent of its design strength based on field cylinder breaks before placing column forms.
 2. Place concrete in one continuous operation.
 3. Allow concrete to set at least two days before placing caps.
 4. Do not place concrete in the superstructure until the columns have been stripped and approved.

- E. Substructure Concrete: Do not place the superstructure load on the bents or abutments until they have been in place at least seven days or attained 75 percent of the design strength based on field cylinder breaks.

3.3 BOX CULVERTS

- A. Allow base slab and footing to cure until they have both attained 75 percent of their design strengths based on field cylinder breaks before the remainder of the culvert is constructed.
- B. Construct side walls and top slab monolithically unless the wall height exceeds 10 ft. Keep the construction joints vertical and at right angles to the axis of the culvert.
- C. When side walls and top slab are not placed monolithically, construct shear keys in the top of the side walls for anchoring the top slab.
- D. Construct wingwalls monolithically.
- E. Do not backfill until all concrete has attained 100 percent of its required design strength based on field cylinder breaks.

3.4 CONCRETE SLOPE PROTECTION

- A. Preparing subgrade:
 - 1. Prepare the area to be paved by smoothing and shaping the berms and slopes and excavating for the cut-off walls.
 - 2. Fill and compact all depressions and humps.
 - 3. Furnish extra material to properly finish the slopes when required.
 - 4. Compact all soft and yielding material resulting in a firm and substantial subgrade of uniform density.
 - 5. Thoroughly sprinkle the area with water before placing the concrete.
 - 6. Have the Engineer approve all surfaces before placing concrete.
- B. Placing concrete:
 - 1. Do not place concrete upon spongy, frozen, or unstable surfaces.
 - 2. Provide concrete of a consistency that it can be placed on the slopes without deformation.
 - 3. Complete all scoring as indicated on the plans.
 - 4. Complete the entire slope protection in one placement if possible, or terminate the placement with a construction joint located in a scoring or at the junction of the slope and the abutment.
 - 5. Finish concrete using a Floated Surface Finish according to this Section, article 3.11. Cure according to Section 03390.

- C. Sealing joints and closures:
1. Furnish 1-inch thick, rigid plastic foam (styrofoam) for all expansion joints located between structural members and the slope protection.
 2. Place the rigid plastic foam material against the surface of all structural members before placing the concrete slope protection.
 3. Anchor the rigid plastic foam in place with a compatible adhesive or other approved methods.
 4. Seal this area just before final inspection.
 5. Remove curing compounds, oil, grease, dirt, and any other foreign materials from concrete surfaces and grooves by sandblasting or other permitted methods.
 6. Place the backer rod and sealant after the concrete has properly cured.
 7. Apply the backer rod and sealant to clean and dry concrete surfaces.
 8. Place sealant with hand or power-operated caulking guns after placing the backing materials. Refer to Section 03152.
 - a. Limit the depth of sealant in the groove to $\frac{3}{8}$ inch.
 - b. Start the placement at one side and proceed to the other side on horizontal grooves and from top to bottom on vertical grooves.
 - c. Use a concave pointing tool with soap solution to tool the sealant.
 9. Do not place the sealant unless temperatures are at least 50 degrees F and rising.
- D. Replacement
1. Prepare subgrade, place concrete and seal joints and closures per this Section, paragraphs A, B and C.
 2. Place concrete slope protection within seven days after removing damaged concrete slope protection. Refer to Section 03055.
 3. Connect reinforcement to existing concrete slope protection to remain in place as shown in the plans.
 4. Use a sealant that meets the requirements in Section 03152.

3.5 PLACING CONCRETE

- A. Do not place concrete without approval.
- B. Remove struts, stays, and braces that hold the forms in correct shape and alignment when no longer necessary.
- C. Mix and transport concrete according to the limitations specified in Section 03055.
- D. Do not deviate from the placement schedule without written approval.

- E. If the concrete cannot be protected during adverse weather, the Engineer may postpone placement operations.
- F. Observe the following precautions when handling concrete:
1. Avoid segregation of the ingredients.
 2. Arrange chutes, troughs, or pipes used as aids in placing concrete so the concrete does not separate.
 3. Use metal or metal-lined chutes and troughs. (Do not use aluminum.)
 4. Equip chutes with baffle boards or a reversed section at the end of the outlet when placing on steep slopes.
 5. Extend open troughs and chutes down inside the forms or through holes left in the forms; terminate the ends in vertical downspouts.
 6. Thoroughly flush all chutes, troughs, and pipes with water before and after each placement.
 7. Do not allow the free-fall of concrete to exceed 10 ft for thin walls (maximum 10 inch thickness) or 5 ft for other types of construction without the use of a tremie or a flexible metal spout.
 8. Use flexible metal spout sections composed of conical sections not more than 3 ft long, with the diameter of the outlet and the taper of the various sections such that the concrete does fill the outlet and retards concrete flow.
- G. Observe the following precautions when placing concrete:
1. Deposit concrete as close as possible to its final position, without allowing it to flow laterally in the form.
 2. Spread fresh concrete in horizontal layers with thickness not greater than what can be compacted with vibrators.
 3. Do not use vibrators to flow concrete laterally.
 4. Limit placement interruptions to 45 minutes.
 5. Place and compact each layer before the preceding layer has taken initial set.
 6. Do not place concrete in water flowing under head within the area of a footing.
 7. Pass the screed over the area with a screed face device to measure the cover before concrete placement.
 8. Relocate and tie reinforcing steel that projects above the specified level before placing the concrete.
 9. Raise and support reinforcing steel that is more than ¼ inch below the specified level before placing the concrete.
 10. Firmly support screed rails for bridge deck slabs to prevent movement during concrete placement. When using a finishing machine, support the machine rails on the bridge beams. (Do not place the machine rails on the forms unless the form supports have been strengthened and the Engineer gives written approval.)

- H. Observe the following precautions when compacting concrete:
 - 1. Use high frequency internal vibrators to compact all concrete for structures (except concrete placed under water).
 - 2. Supply enough vibrators to compact the fresh concrete to the desired degree within 15 minutes after it is deposited in the forms.
 - 3. Supply at least two vibrators for structures involving more than 25 yd³ of concrete.
 - 4. Do not attach vibrators to or against the forms or the reinforcing steel.
 - 5. Do not allow vibrators to penetrate layers of concrete that have taken initial set.
 - 6. Use spades or wedge-shaped tampers to secure a smooth and even texture of the exposed surface.
- I. When using High Early Strength Concrete, verify that design strength has been obtained by field cylinder breaks.

3.6 PLACING CONCRETE UNDER WATER

- A. Place and deposit concrete under water when specified on the plans.
- B. Seal the forms or cofferdams watertight.
- C. Do not pump water while placing concrete or disturb the concrete until it has set at least 24 hours, or attained at least 50 percent of its design strength.
- D. Regulate placing to keep surfaces approximately horizontal at all times.
- E. Place the concrete by beginning at one end of the form and progressing in a zig-zag movement from side to side across the length of the form.
- F. Place the concrete using a tremie or concrete pumping equipment.
- G. Observe the following steps when placing concrete with a tremie:
 - 1. Use an 8-inch to 12-inch diameter steel tube tremie constructed with watertight connections, a hopper to receive concrete, and a device at the bottom to exclude water from entering the tube.
 - 2. Use support that permits the discharge end to move over the entire top work surface and permits the tremie to be rapidly lowered to stop or retard flow when necessary.
 - 3. Minimize the number of tremie location shifts for continuous placement.
 - 4. Keep the tremie tube full to the bottom of the hopper during placement.
 - 5. Slightly raise the tremie when a batch is dumped into the hopper, but do not raise it out of the concrete at the bottom until the batch discharges to the bottom of the hopper. If the concrete seal around the tube is lost, re-plug the end and refill the tube with concrete.

3.7 PUMPING CONCRETE

- A. Place concrete with a concrete pump in good operating condition. Replace pump that causes excessive or erratic loss of air entrainment.
 - 1. Use a pump that produces a continuous stream of concrete without air pockets.
 - 2. Do not add water to the concrete in the pump hopper.
- B. Do not allow pump vibrations to damage freshly placed concrete.
- C. Do not use concrete contaminated by the priming or cleaning of the pump.

3.8 LIMITATIONS

- A. If either mixing, placing, or finishing occurs after daylight hours, light the work site so all operations are plainly visible. Refer to Section 00555.
- B. Keep all traffic off concrete bridges and culverts for 14 days after final concrete placement.
- C. Cold Weather:
 - 1. Cold weather limitations apply when the temperature is likely to fall below 40 degrees F within 14 days of placement.
 - 2. Comply with the following regulations for placing concrete in cold weather:
 - a. Submit a written plan for approval 14 calendar days before concrete placement.
 - b. Do not use chemical additives in the concrete to prevent freezing.
 - c. Provide all necessary cold weather protection for in-place concrete (cover, insulation, heat, etc.).
 - d. Do not place concrete in contact with frozen surfaces.
 - e. Produce concrete with a temperature between 60 degrees F and 90 degrees F at the time of placing.
 - f. Adequately vent combustion-type heaters that produce carbon monoxide.
 - g. Maintain the concrete temperature above 50 degrees F and below 120 degrees F with no more than a 40 degree F temperature gradient at any one time for the first 14 days after placing.
 - h. Protect the concrete from freezing until a compressive strength of at least 3,500 psi has been achieved.
 - i. Maintain moist conditions for exposed concrete not in contact with forms; avoid loss of moisture from the concrete due to heat applied.

- j. Limit the drop in temperature next to the concrete surfaces when removing heat to 20 degrees F during any 12-hour period until the surface temperature of the concrete reaches that of the atmosphere.
 - k. Determine the concrete temperature with a surface thermometer insulated from surrounding air.
 - l. Remove and replace concrete damaged by frost action at no additional cost to the Department.
- 3. Heating Aggregate and Water:
 - a. Provide and operate heating devices at no additional cost to the Department when heated aggregates are required.
 - b. Aggregates must be free of ice.
 - c. Heat aggregates uniformly, when required. Avoid overheating or developing hot spots.
 - d. Use either steam or dry heat.
 - e. To avoid the possibility of a quick or flash set of the concrete when either the water or aggregates are heated to above 100 degrees F, they should be combined in the mixer first before the cement is added.
 - 1) If this mixer-loading sequence is followed, water temperatures up to the boiling point can be used provided the aggregates are cold enough to reduce the final temperature of the aggregates and water mixture to less than 100 degrees F.
- D. Hot Weather: Cool all form surfaces that will come in contact with the concrete to below 95 degrees F.
- E. Hot Weather (Only Decks and Approach Slabs)
 - 1. Begin placing concrete when the temperature is declining.
 - 2. Begin batching operations when the air temperature in the shade is 85 degrees F or less.
 - 3. Discontinue placing when the temperature reaches 80 degrees F in the shade and is increasing.
- F. Surface Evaporation:
 - 1. Surface evaporation limitations apply and may occur at any time of the year, when any combination of air temperature, relative humidity, and wind velocity, that have the potential to impair the quality of fresh or hardened concrete or otherwise result in abnormal properties. Submit a written plan for approval 14 calendar days before concrete placement that shows proper attention will be given to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures and water evaporation that could impair strength or serviceability of the concrete. Refer to ACI 305.

2. The surface evaporation plan may include any of the following actions:
 - a. Construct windbreaks or enclosures to effectively reduce the wind velocity throughout the area of placement.
 - b. Use fog sprayers upwind of the placement operations to effectively increase the relative humidity.
 - c. Reduce the temperature of the concrete by shading the material storage area or production equipment, cool aggregate by sprinkling, cool aggregate or water by refrigeration or by replacing a portion or all of the mix water with flaked or crushed ice to the extent that the ice will completely melt during mixing of the concrete.
 - d. Adjustment of the placement schedule.
 - e. Use an approved water-based mono-molecular polymer liquid evaporative reducer at application rates recommended by the manufacturer. Do not use as a finishing aid.

3.9 EXPANSION JOINTS AND BEARINGS

- A. For expansion joints, refer to Section 05832.
- B. For bearings, refer to Section 05822.
- C. Adjust bearing positions and joint widths as shown on plans.

3.10 CONSTRUCTION JOINTS

- A. Make construction joints where shown on plans or in the placing schedule.
- B. Obtain Engineer's written approval when additional construction joints are desired and meet the following requirements:
 1. Place and construct without impairing strength and appearance.
 2. Place in planes perpendicular to the principal lines of stress and at points of minimum shear.
 3. Make monolithic structures by extending the reinforcing across the joint.
 4. Avoid construction joints through paneled wing walls or large surfaces which are to be treated architecturally.
 5. Make a straight line joint across the face of the pour for the full width of the bridge deck.
 6. Leave a rough surface to increase the bond with the concrete placed later.
 7. Form tapered sections with an insert so that the succeeding layer of concrete ends in a section at least 6 inches thick.
 8. Place a bulkhead from the surface to the top mat of steel to ensure a straight vertical face. Shape the concrete below the top steel to a near vertical face in line with the bulkhead.

9. When a bulkhead cannot be placed, establish a straight vertical face by saw cutting to a minimum depth of 1 inch. Shape the concrete below the saw cut to a near vertical face.
- C. Before resuming concrete placement, meet the following:
1. Re-tighten forms.
 2. Roughen the surface of hardened concrete without leaving loosened particles or damaged concrete.
 3. Clean off concrete surface of foreign matter and laitance by sandblasting.
 4. Saturate concrete surface with water.
 5. Apply epoxy adhesive as specified to face of construction joints.

3.11 CONCRETE SURFACE FINISHING CLASSIFICATIONS

- A. Ordinary Surface Finish: A true and uniform finished surface.
- B. Rubbed Finish: A surface smooth in texture and uniform in appearance, free of all form marks or irregularities.
- C. Wire Brush or Scrubbed Finish:
1. A finished surface with the cement surface film completely removed and the aggregate particles exposed leaving an even-pebbled texture.
 2. An appearance ranging from fine granite to coarse conglomerate depends on the size and grading of the aggregate used.
- D. Floated Surface Finish:
1. For flat work: strike off and use a floated surface finish.
 2. For bridge decks and approach slabs: machine finish only.

3.12 CONCRETE SURFACE FINISHING

- A. Give all formed concrete surfaces at least an Ordinary Surface Finish except as specified otherwise.
- B. Use other types of finishes as required in addition to the Ordinary Surface Finish.
- C. Provide a Rubbed Finish for all surfaces that cannot meet Ordinary Surface Finish requirements due to irregularities, honeycombing, excessive surface voids, discoloration, and other defects.

3.13 CONCRETE SURFACE FINISHING PROCEDURES

A. Ordinary Surface Finish:

1. After removing forms, remove all fins and projections.
 - a. Clean, point, and true all honeycomb spots, broken corners or edges, cavities made by form ties, and other holes and defects.
 - b. Keep all areas to receive mortar saturated with water for at least 30 minutes before mortar placement.
2. For pointing, use a mortar of cement and fine aggregate, not more than one hour old, mixed in the proportions used in the grade of concrete being finished.
3. Cure the mortar patches and rub to blend with surrounding concrete.
4. Tool and free all joints of mortar and concrete. Leave the full length of the joint filler exposed with clean and true edges.

B. Rubbed Finish:

1. Wet the surface of concrete while still green, paint with grout, and rub with a wooden float until the surface is covered with a lather of cement and water.
 - a. A thin grout (one part cement, one part fine sand) may be used in the rubbing.
 - b. Let this lather set for at least five days, then rub lightly with a fine carborundum stone until smooth.
2. For hardened concrete, use a mechanically operated carborundum stone to finish the surface at least four days after placing.
 - a. Finish in the same manner as above; however, let the lather set for at least 15 days before lightly rubbing with a fine carborundum stone until smooth.
3. Commercial grade rubbing mortar may be used if approved by Engineer.

C. Wire Brush or Scrubbed Finish:

1. After the forms are removed and the concrete is green, scrub the surface with stiff wire or fiber brushes using a solution of muriatic acid (one part acid, four parts water).
2. Once the scrubbing produces the desired texture, wash the entire surface.
3. Use water mixed with 5 percent by volume ammonium hydroxide to remove all traces of the acid.

D. Floated Surface Finish on flat work other than bridge decks and approach slabs:

1. Striking Off:
 - a. After compaction, carefully rod and strike off the surface with a strike board following the cross sections and grades shown on the plans.
 - b. Allow for camber as required.

- c. Operate the strike board longitudinally or transversely and move it forward with a combined longitudinal and transverse motion, ensuring that neither end is raised from the side forms during the process.
 - d. Keep a slight excess of concrete in front of the cutting edge at all times.
 - 2. Floating:
 - a. Use longitudinal, or transverse floating, or both to create a uniform surface.
 - b. Longitudinal floating is required except in places where it is not feasible.
 - 3. Longitudinal Floating:
 - a. Work the longitudinal float, operated from foot bridges, with a sawing motion while holding it parallel to the road centerline.
 - b. Pass gradually from one side of the pavement to the other. Move the float forward one-half of its length and repeat operation.
 - c. Substitute machine floating, if equivalent results are produced.
 - 4. Transverse Floating:
 - a. Operate the transverse float across the concrete surface by starting at the edge and slowly moving to the center and back again to the edge.
 - b. Move the float forward one-half of its length and repeat the operation.
 - c. Preserve the crown and cross section of the concrete surface.
 - 5. Straightedging:
 - a. Test the concrete surface for trueness with a straightedge after the longitudinal floating has been completed and the excess water has been removed, but while the concrete is still plastic.
 - b. Furnish and use an accurate 10 ft straightedge held parallel to the road centerline in contact with the surface.
 - c. Check the entire area, immediately filling depressions with freshly mixed concrete, then strike off, consolidate, and refinish.
 - d. Cut down and refinish high areas.
 - e. Continue the straightedge testing and re-floating until the concrete surface is at the required grade and contour.
- E. Floated Surface Finish for bridge decks and approach slabs:
 - 1. Machine-finish exposed surfaces unless otherwise permitted.
 - 2. Finish concrete by striking off and floating the surface.
 - 3. Allow the Engineer enough time to inspect finishing machines during daylight hours before concrete placement.
 - 4. Stop finishing operations hampered by darkness unless lighting facilities are provided.

5. Extend finishing machine rails beyond both ends of the scheduled placement, and allow sufficient distance to permit the float to fully clear the concrete.
6. Use adjustable rails set to elevations established by the Engineer, installed to prevent springing or deflection under the weight of the finishing equipment, and placed to operate without interruption.
7. Place screed machine parallel to the abutments and bents within 10 degrees.
8. Support screed rails to prevent movement during placing of the concrete.
9. Either support finishing machine rails on the bridge beams or on form supports stiffened to prevent deflection.
 - a. Obtain written approval before using form supports.
 - b. This may require load tests.
10. Attach a measuring device to the screed face and pass it over the area.
11. Before placing concrete, relocate and tie reinforcing steel that projects above the specified level, and raise and support steel that is more than $\frac{1}{4}$ inch below the specified level.
12. Place concrete in a uniform heading approximately parallel to the screed machine.
13. Limit the rate of placing to allow enough time to finish the surface before initial set.
14. Continuously place concrete the full length of the structure or superstructure unit unless otherwise shown or approved.
15. Provide sufficient material, equipment, and manpower to place deck concrete at a minimum rate of $25 \text{ yd}^3/\text{hour}$.
16. Strike off the surface to the required elevations with the finishing machine immediately after placing and consolidating the concrete.
17. Do not add water to the concrete in front of or behind the screed.
18. Have the strike-off method and equipment approved. Maintain satisfactory performance. Use equipment capable of finishing concrete within the surface tolerances specified. Maintain satisfactory consolidation and surface tolerance to prevent shutdown and rejection of the equipment.
19. Furnish a 10 ft straightedge to check the surface tolerance, placed both longitudinally and transversely, immediately behind the screed machine and hand-finished areas.
20. Correct irregularities greater than $\frac{1}{8}$ inch from the straightedge, before additional placement, and immediately fill depressions with concrete, and refinish.
21. Cut down and refinish high areas.
22. Continue straightedge testing and corrective measures until the entire surface is free of observable departures from the straightedge.

- F. Final texturing for bridge decks and approach slabs: (a textured hardened finish):
 - 1. After floating, do not texture finish concrete deck surfaces that are to be covered by a water-proofing membrane system.
 - 2. Use a texture process that produces regular $\frac{1}{8}$ inch wide transverse grooves spaced randomly from $\frac{1}{2}$ inch to $\frac{3}{4}$ inch on centers and $\frac{1}{8}$ inch deep.
 - 3. Keep the finished surface free from porous spots and surface irregularities.
 - 4. Furnish a work bridge that follows the finishing machine to facilitate texturing and application of the membrane-curing compound.
 - 5. Check the surface smoothness for acceptance after the concrete has hardened.
 - 6. If the surface deviates more than $\frac{1}{8}$ inch from a 10 ft straightedge, remove irregularities by grinding following Section 02752.

3.14 CURING

- A. Refer to Section 03390.

3.15 FORM REMOVAL

- A. Obtain approval before removing forms.
- B. Remove all forms from the concrete surfaces.
- C. Do not use any method of form removal likely to cause overstressing of the concrete.
- D. Remove supports to permit the concrete to uniformly and gradually take the stresses due to its own weight.
- E. Do not remove forms used in ornamental work, railings, parapets, and exposed vertical surfaces for at least six hours after placement.
- F. To determine the condition of columns, always remove forms before removing shoring from beneath beams and girders.
- G. Removing falsework:
 - 1. Do not remove deck falsework until the backfill at the abutments has been placed up to the bottom of the approach slab.
 - 2. Do not remove falsework supporting the deck of rigid frame structures until the fill has been placed in back of the vertical legs.
 - 3. Keep falsework and forms in place under slabs, beams, and girders for 14 days after the day of last concrete placement. Forms for slabs having clear space of less than 10 ft may be removed after seven days.

4. In cold weather, keep forms and falsework in place as approved in the written plan for cold weather concrete.
- H. Patch formed surfaces within 24 hours after form removal:
1. Cut back and remove all projecting wire or metal devices used for holding the forms in place and that pass through the body of the concrete at least 1 inch beneath the surface of the concrete.
 2. Remove lips of mortar and all irregularities caused by form joints.
 3. Fill all small holes, depressions, and voids with cement mortar mixed in the same proportions as that used in the body of the work.
 4. To patch larger holes or honeycombs, obtain a solid uniform surface by chipping away coarse or broken material.
 - a. Cut away feathered edges to form faces perpendicular to the surface.
 - b. Cover with epoxy-adhesive coating as specified. AASHTO M 235, Type II
 - c. Fill the cavity with stiff mortar composed of one part Portland Cement to two parts sand thoroughly tamped into place.
 - d. Pre-shrink the mortar by mixing it approximately 20 minutes. Vary the time according to manufacturer's recommendations, temperature, humidity, and other local conditions.
 - e. Float the surface of this mortar with a wooden float before initial set.
 - f. Keep the patch wet for five days.
 - g. After curing, rub patches on exposed surfaces to blend them with surrounding concrete.
 - h. Add coarse aggregate to the patching material when patching large or deep areas.
 - i. Make a dense, well-bonded, and properly cured patch.
- I. Areas with extensive honeycombing will be rejected. After receiving written notice of rejection, remove and rebuild the structure in part or wholly, as specified, at no additional cost to the Department.
- J. If the Contractor elects to place inserts along the bottom edges of the precast concrete deck panels to form the closure pour joints, apply the following requirements after fully removing all the closure joint forms:
1. Cut off cast-in-place anchors at least 1 inch below the face of slab and repair per this Section, article 2.2.
 2. Fill all voids with dry-pack mortar flush with the bottom of slab.
 3. Fill voids created by the removal of re-usable concrete anchors with dry-pack mortar flush with the bottom of slab.
 4. Dry-pack mortar will be composed of one part Portland cement to two parts sand.

3.16 MISCELLANEOUS CONSTRUCTION

- A. Drainage and weep holes:
 - 1. Construct drainage and weep holes at locations indicated on the plans or as directed.
 - 2. Place ports or vents for equalizing hydrostatic pressure below low water.
 - 3. Use non-corrosive materials for weep hole forms.
 - 4. Remove wooden forms after the concrete is placed.
 - 5. Paint exposed surfaces of metal drains as indicated on the plans.
- B. Anchor Bolts: Securely and accurately set all necessary anchor bolts in piers, abutments, or pedestals as the concrete is being placed.
- C. Bearing plate areas:
 - 1. Finish bridge seat bearing areas high and rub or grind to grade level within an allowable tolerance of $\pm 1/16$ inch within a tolerance of $\pm 1/8$ inch of the elevation shown on the plans.
 - 2. Do not grout under bearing plates.

3.17 CLEANING

- A. Clean up by removing all falsework and falsework piling, (down to 2 ft below the finished ground line) rubbish, and temporary building materials before final inspection.

END OF SECTION